

# AN ACCURATE ONE-STEP PLANE STRESS ELASTOPLASTICITY ALGORITHM FOR LARGE SCALE EXPLICIT ANALYSES<sup>1</sup>

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Shell elements in explicit finite element codes are commonly treated as assemblages of plane stress laminae, hence the algorithms for the plane stress constitutive calculations play a significant role in the robustness and efficiency of the elements. An asymptotic approach is presented to find the analytical solution for the stress state of a von Mises material under plane stress condition. This method can be simplified to an one-step algorithm for explicit finite element codes.

In comparison to the existing iterative algorithms in the explicit code DYNA3D [1,2], the proposed method is more efficient and easier to vectorize since no iterations are required. This method offers the same accuracy as the iterative methods in [1,2], which is far superior to other non-iterative schemes such as the Stress Scaling Algorithm in [2]. Both isotropic and kinematic hardening laws can be accommodated, and rate dependent material characteristics can be easily implemented.

Run time studies show 35-50% improvement on constitutive equation evaluation alone and 10-30% improvement on overall execution times for large scale problems with complex contact definitions. An implementation summary reveals the robustness of this algorithm.

## References

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2. Whirley, R. G., J. O. Hallquist and G. L. Goudreau (1988), *An Assessment of Numerical Algorithms for Plane Stress and Shell Elastoplasticity on Supercomputers*, University of California, Lawrence Livermore National Laboratory, Livermore, CA. (UCRL-99690).

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